Space Weather Technical Forecast

Issued on Monday, 03 June 2024 at 12:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate solar activity likely with a slight chance of X-class flares. Glancing CME impacts possible into the period with a chance of G1/G2 Minor or Moderate Geomagnetic Storms.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate during the last 24 hours, with two M-class flare from AR3697. The largest peaking at 03/1155 UTC at M3.2. There are now ten numbered spots on the disc. AR3697 in the southern disk remains the most notable spot, by far the largest region and also the most magnetically complex with multiple delta spots visible. Areal extent has reduced somewhat however, with continued signs of fragmentation. The newly numbered AR3703 region in the southeast has shown the most development in recent hours will be monitored. Other regions on the disc either are stable or have shown only slight evolution. There are also currently a number of large and significant filaments of the solar disc.

No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Observations by ACE at L1 showed speeds persisting at background at 300-350 km/s, with density at predominantly average levels. The Interplanetary Magnetic Field, Bt, was weak, 3-6nT with the north-south component, Bz, also varying weakly. Phi angle was generally negative (towards the Sun), briefly rotating to be slightly positive (away from the Sun) at times, increasingly so by the end of the period. Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux at GOES18 remained at background levels with no solar radiation storms occurring. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels with the associated 24-hour fluence well below the Active threshold. Observed fluence at 03/0000 UTC was 3.64e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast with further M-class flares likely and a slight chance of isolated X-class flares, these mainly from AR3697.

Solar Wind / Geomagnetic Activity: A glancing blow from a weak CME associated the C7.5 flare of AR3698 on 31 May remains possible day 1 (03 Jun), although confidence is low with the strength of any arrival due to the faint and apparent weak nature of the CME. Analysis of a CME associated with the long period M7.3 flare from AR3697, peaking at 01/1940 UTC. Analysis of this feature suggest the potential for a glancing impact sometime later day 2 (04 Jun), or perhaps more likely early day 3 (05 Jun). Otherwise largely background solar winds are forecast to persist.

Geomagnetic activity is forecast to be mainly Quiet (Kp 0-2) initially, with just a chance of

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Unsettled or Active intervals (Kp 3-4) should we see any glancing CME arrival day 1 (03 Jun). The risk of Unsettled to Active conditions increases into day 2 (04 Jun), with a chance of G1-G2 Minor to Moderate (Kp 5-6) Storm intervals associated with any CME arrival later in the day, this risk persisting into day 3 (05 Jun) before gradually easing.

Energetic Particles / Solar Radiation: High energy proton flux is expected to persist at background, but with a slight chance of rising above the S1/Minor Storm threshold given any notable flares. High energy electron flux is forecast to persist at background, with the associated 24 hour fluence forecast to remain below the Active threshold.

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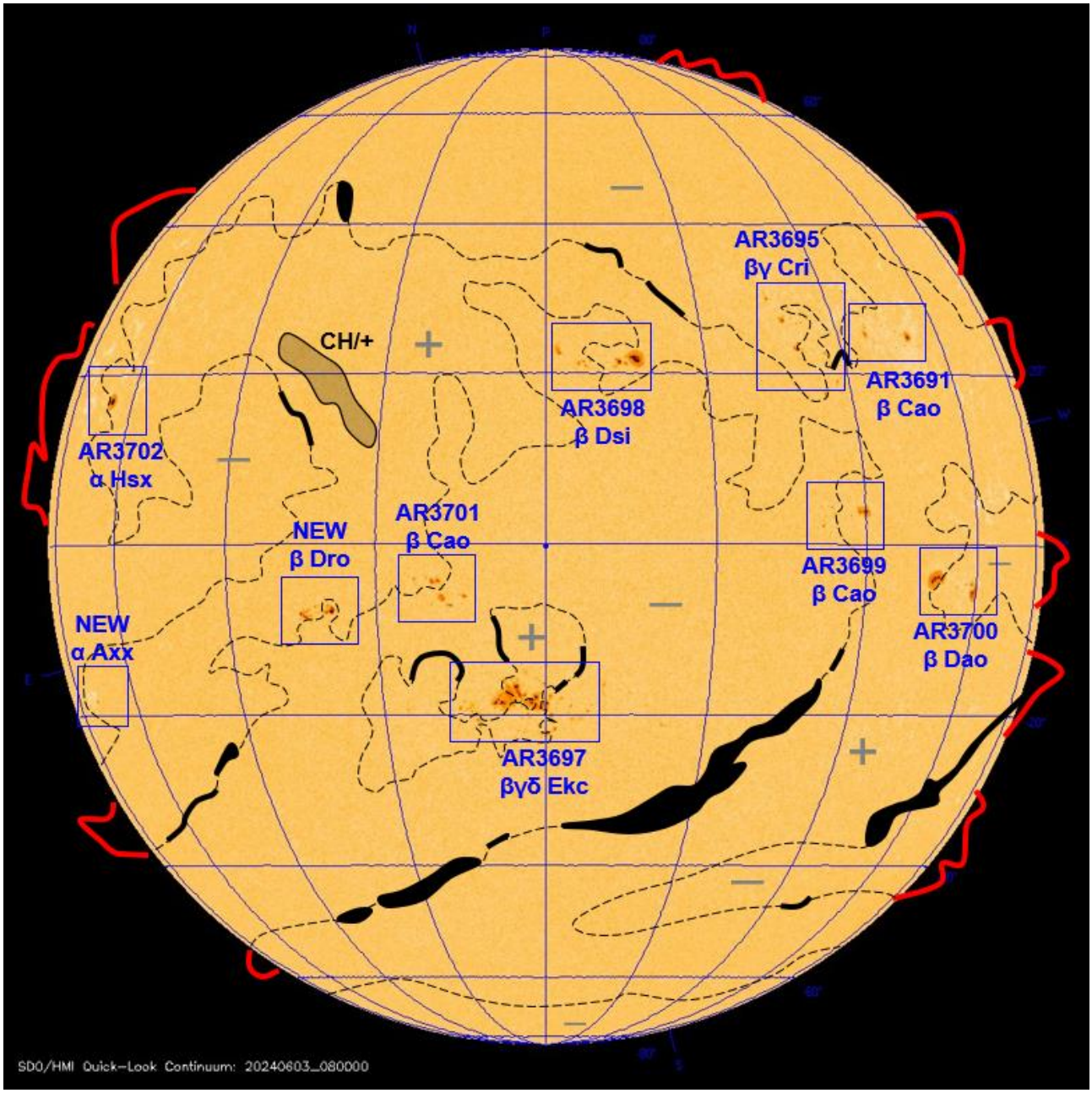
Figure 1. Solar Analysis Valid 03/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A glancing blow from a weak CME associated the C7.5 flare of AR3698 on 31 May remains possible day 1 (03 Jun), although confidence is low with the strength of any arrival due to the faint and apparent weak nature of the CME. The X1.0 flare of AR3697 at 01/1836 UTC was followed by a sympathetic, long period M7.3 flare from the same region, peaking at 01/1940 UTC, with Type II and IV Radio Emissions observed with the second of these flares. A full-halo CME was observed from Earth's frame of reference around the time of the first flare but has been assessed as far-sided, with the second flare resulting in a smaller partial halo CME, potentially Earth-directed but more displaced towards the south and east. Analysis of this second feature suggest the potential for a glancing impact sometime later day 2 (04 Jun), or perhaps more likely early day 3 (05 Jun).

Current background solar winds may see some temporary very weak enhancement from CH41/+ today (03 Jun), perhaps becoming slightly elevated, although confidence is very low regarding this due to the position of CH41 as it approaches the northwest limb. This high speed stream feature is currently overestimated in MOSWOC ENLIL output, leading to reduced confidence in the arrival times of forecast Earth-directed CMEs.

There are also a number of large filaments currently on the Earth-facing disc. These will be closely monitored for any potential Earth-directed eruptions should any of these features lift-off of the solar surface.

Geomagnetic activity is forecast to be mainly Quiet (Kp 0-2) initially, with just a chance of Unsettled or Active intervals (Kp 3-4) should we see any glancing CME arrival day 1 (03 Jun). The risk of Unsettled to Active conditions increases into day 2 (04 Jun), with a chance of G1-G2 Minor to Moderate (Kp 5-6) Storm intervals associated with any CME arrival later in the day, this risk persisting into day 3 (05 Jun) before gradually easing.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	50	50	5
Strong	G3	No	1	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/1205	Partial	C7.5 flare	NE	710 km/s	03/0000 UTC +12hrs	Low confidence
02/0048	Partial	M7.3 flare	SE	700 km/s	05/0000 UTC +- 12hrs	Glancing blow

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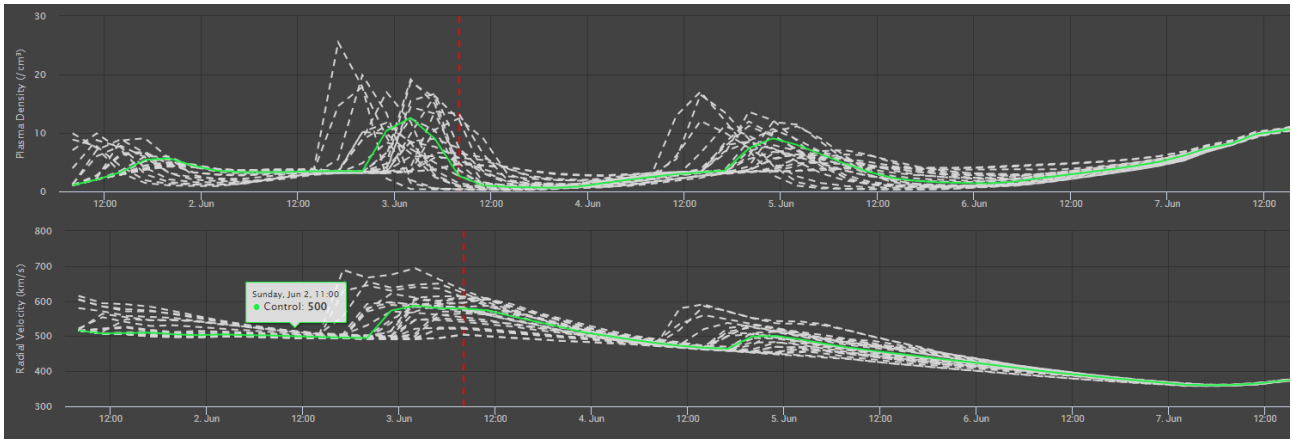
Figure 2: Latest MOSWOC ENLIL Ensemble output. Note continued overestimation of current solar wind speeds, reducing confidence in potential CME arrival times.



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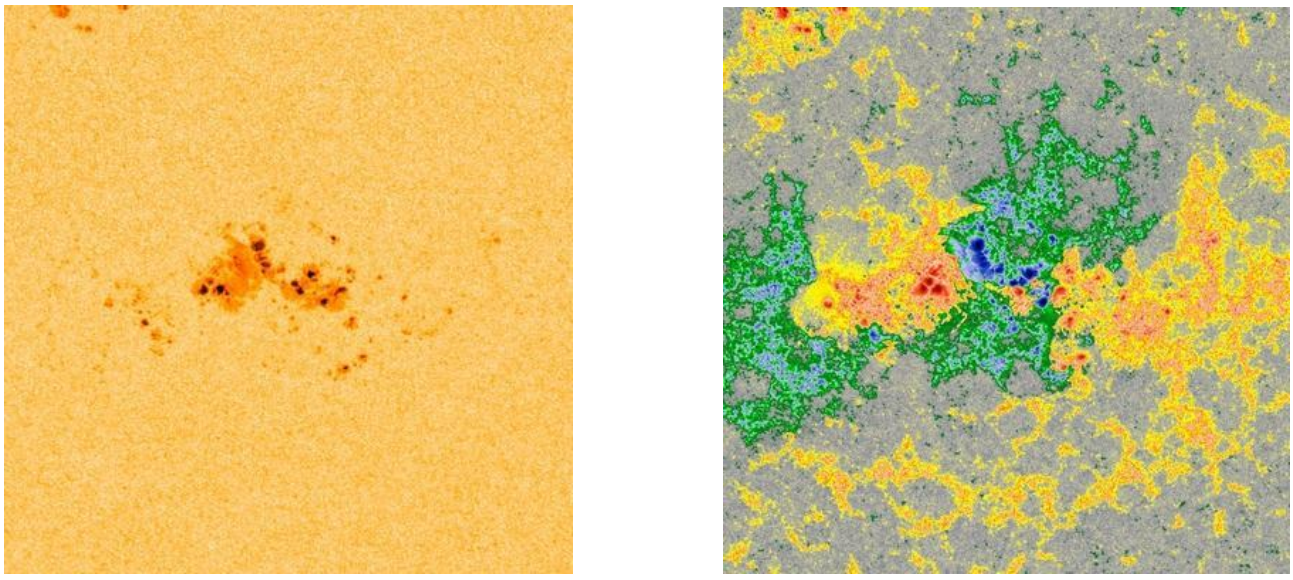
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate during the last 24 hours, with two M-class flare from AR3697. The largest peaking at 03/1155 UTC at M3.2. This region brings a likelihood of further M-class flares and a persistent slight chance of isolated X-class flares. The X-class flare risk level increased somewhat due to the history of AR3697, although the region itself continues to show some signs of fragmentation and a slow reduction in areal extent.

Elsewhere on the disc isolated M-class flares are also possible with several moderately sized spots, with the broad plage area of AR3691 and AR3695 contributing to recent higher C-class flare activity. This area, as well as AR3700 and AR3699 will be approaching the limb by the end of the period but the bulk of current regions will remain visible throughout, and signs in far side sounding data that potentially significant spots on the currant far side may be approaching the eastern limb by day 4 (06 Jun). The risk of flares is therefore kept constant throughout the period pending further developments, particularly to AR3697 in the near term.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	70	70
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: Latest HMIIF and HMIBC images of AR3697, significant magnetic complex visible but with a somewhat atypical small spot structure.



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Solar Radiation Storms - (High Energy Protons):
GOES-18 high energy proton flux is currently at background, with no response observed from the X-flares of AR3697 on 31 May and 01 Jun. This region, however, continues to have the potential for stronger flares, with an steadily improving position for any such flares to eject Earth-directed high energy protons as it transits into the western hemisphere. There is a slight chance of proton flux enhancement occurring and reaching the S1 Minor Storm threshold. Given the potential for stronger flares, it also cannot be completely ruled out that any such proton storm could exceed the strong threshold (S3 Strong radiation storm).

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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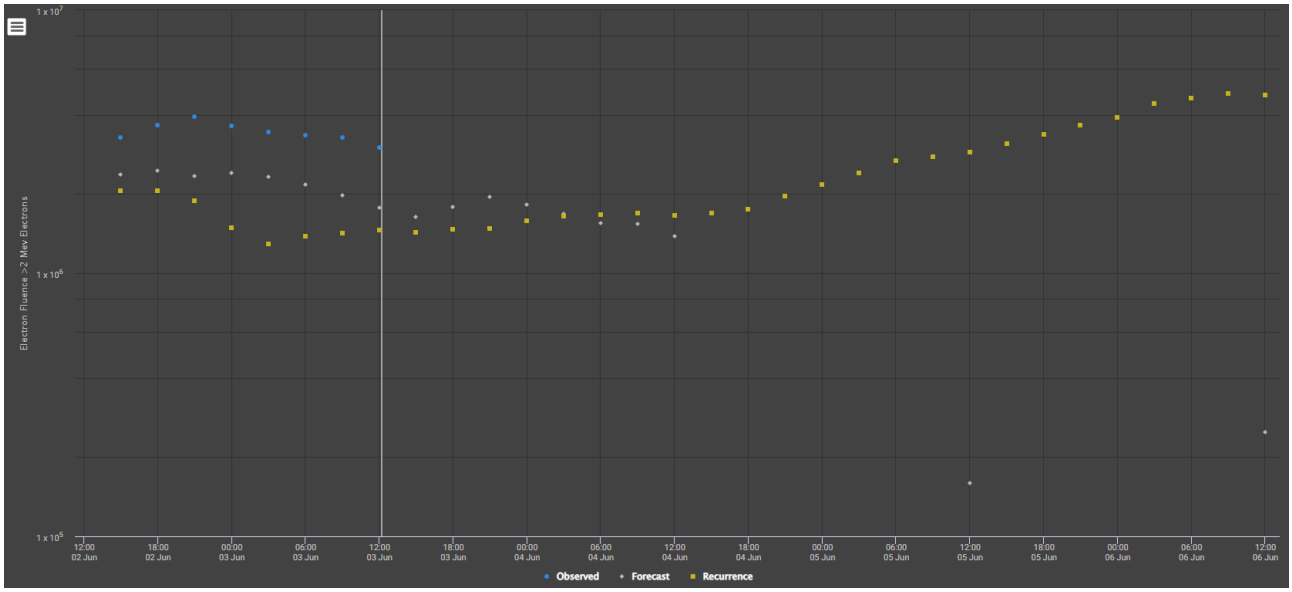
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux, as observed by GOES-16, is expected to persist at mainly background levels, with no notable sources of potential enhancement currently anticipated with any confidence. The associated 24 hour electron fluence is expected to remain well below the Active level, as supported by MOSWOC REFM, which is currently thought to be giving generally good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output.



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